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(54) Apparatus for joining edges

(57) An apparatus for butt jointing opposite edges of a sheet of plastics material to form a tubular sleeve for use as a printing forme comprises two opposed elongate platens (1 and 2) and clamp means (3), Figure 1 (not shown), to clamp the platens together to sandwich the edges of the plastics material to be joined between them. At least one of the platens includes a strip heater 15, Figure 2, extending along it with thermally insulating material 18 extending along both sides thereof. Preferably, the heater 15 has embedded therein two low power electrical heating elements 16 and a single high power element 17. The thermally insulating material 18 ensures that portions of the plastics material adjacent the opposite edges of the sheet are held firmly in place throughout the heat welding operation to ensure that the completed joint is substantially void free and stress free. The heater 15 and the insulating material 18 are enclosed in a polytetrafluoroethylene sleeve 19.

The apparatus may also include nip bars 4 to enable opposite edges of the sheet of plastics material to be clamped into position before the platens are brought together.

Adjustable springs 13 or an inflatable hose (24), Figure 6 (not shown), apply pressure at the nip between the platens. The platen 2 may have thereon a polytetrafluoroethylene coating 6, Figure 2, or a curved polytetrafluorethylene strip (21), Figure 4 (not shown).

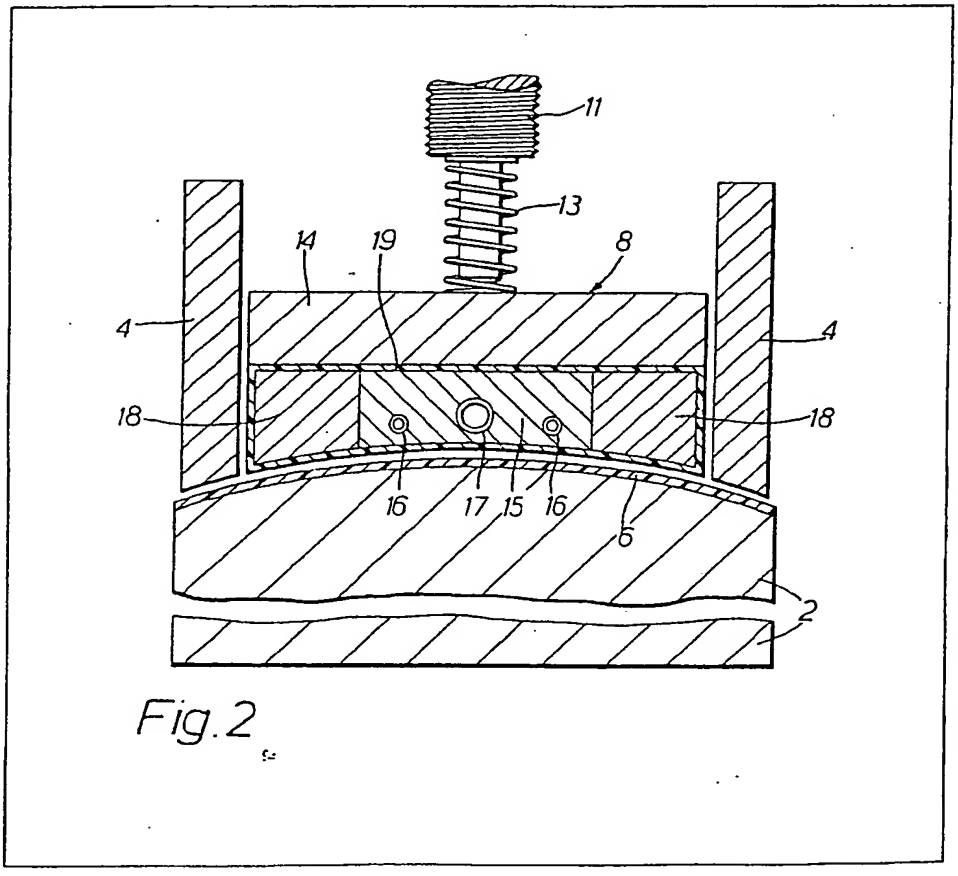

Fig. 2

The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

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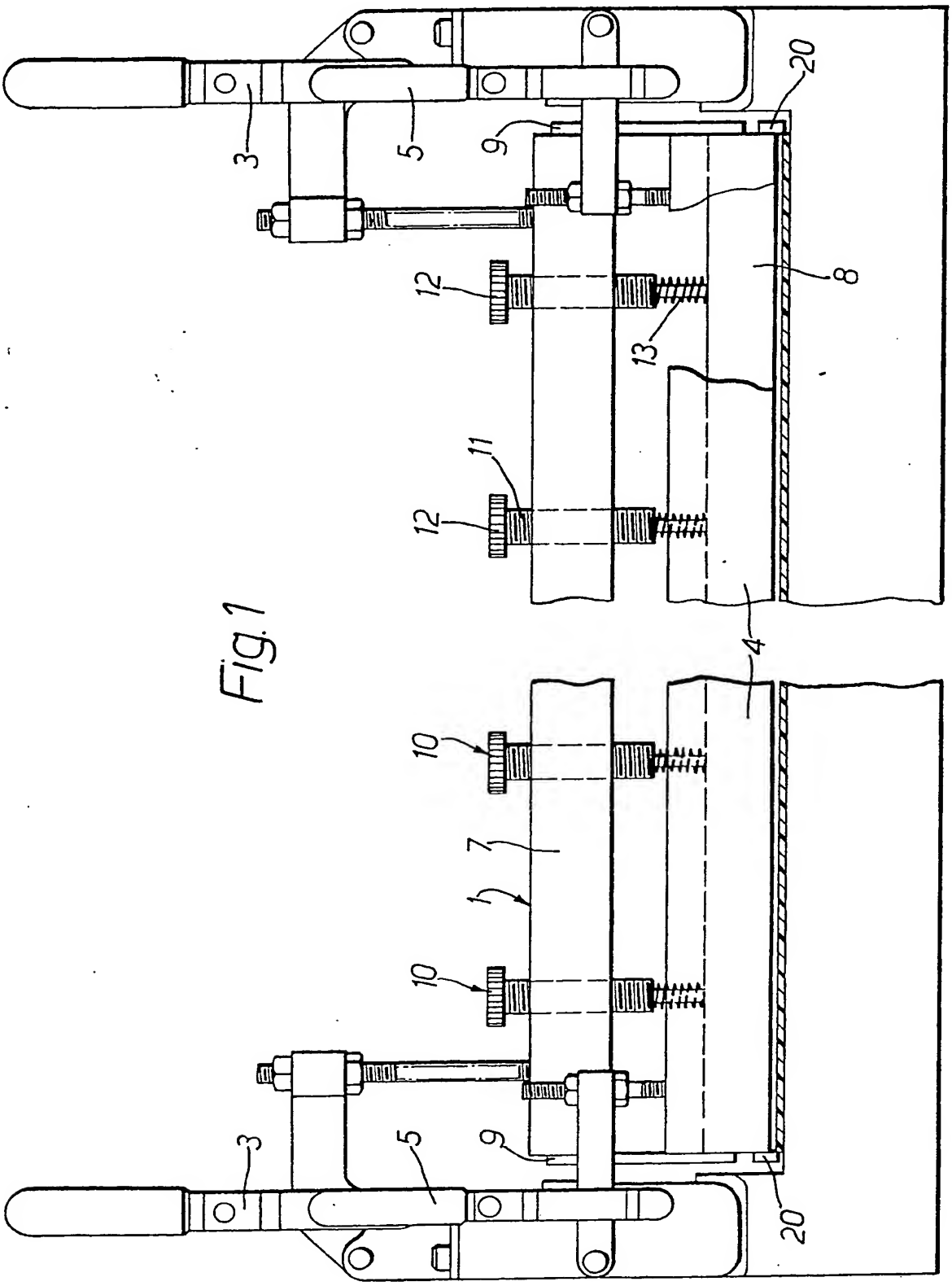


Fig.1

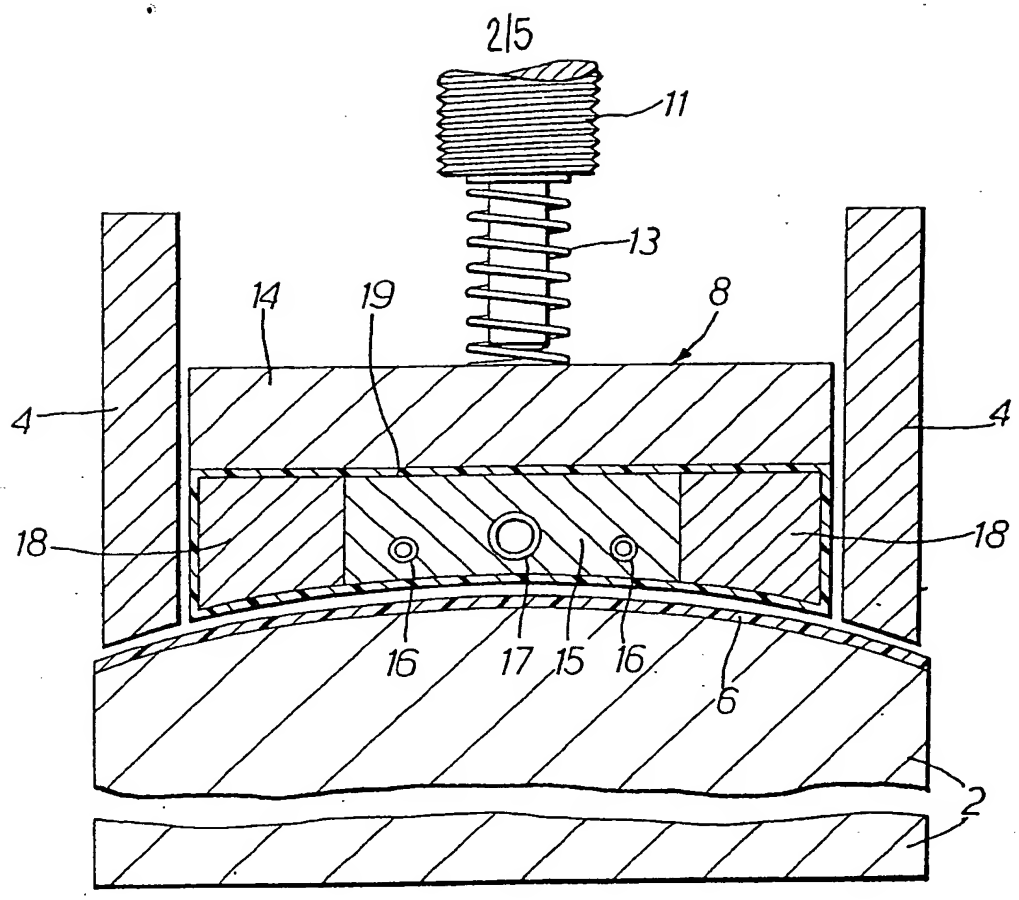


Fig. 2

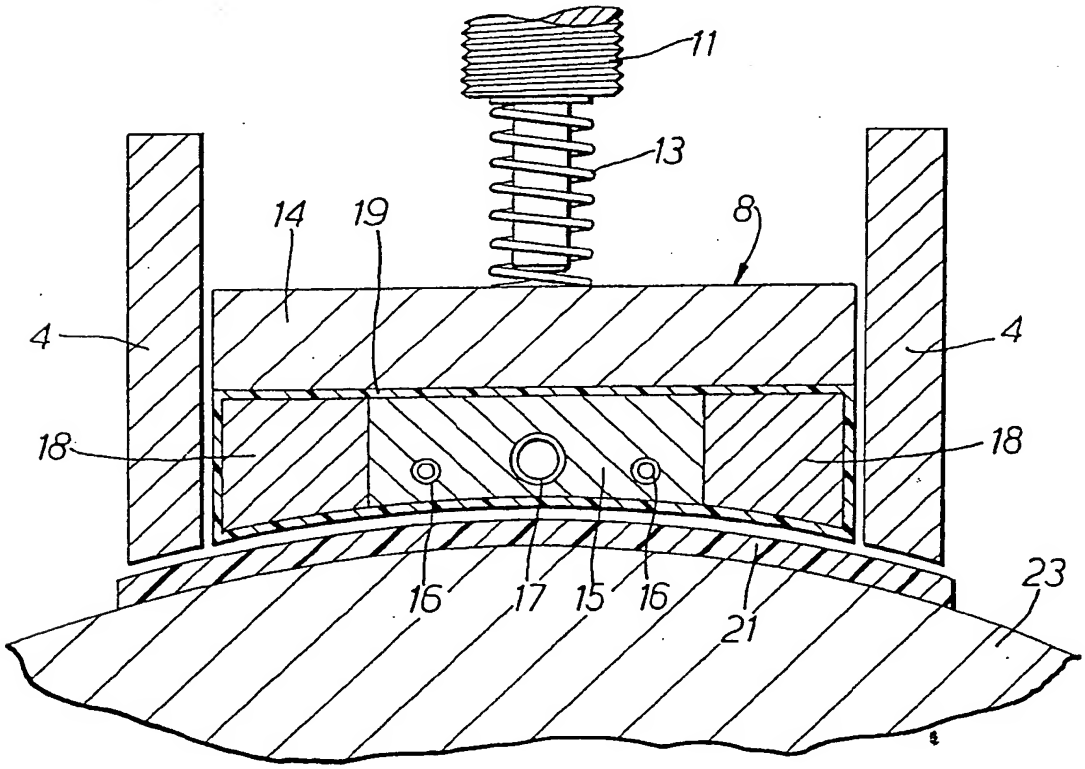


Fig. 4

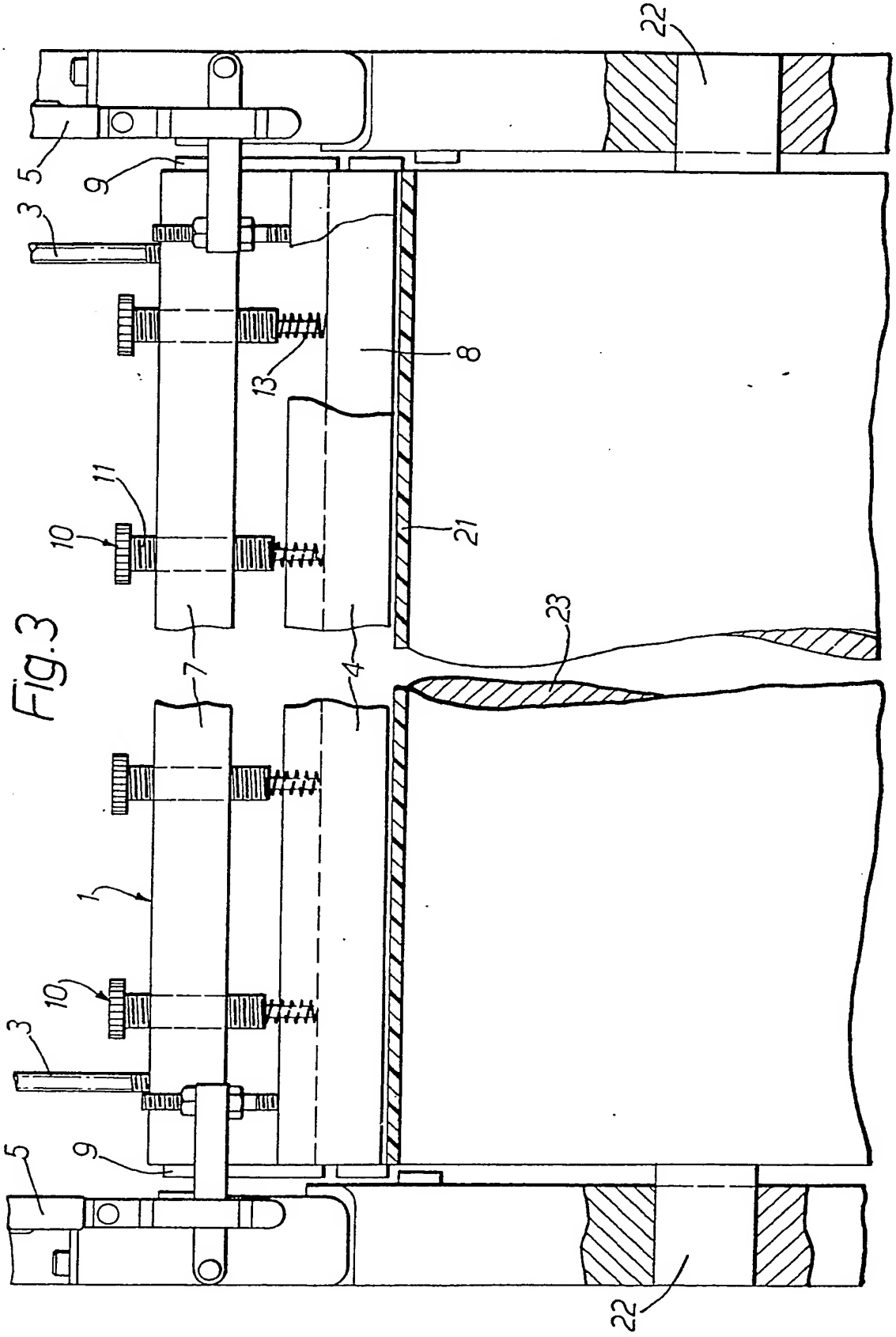


Fig.3

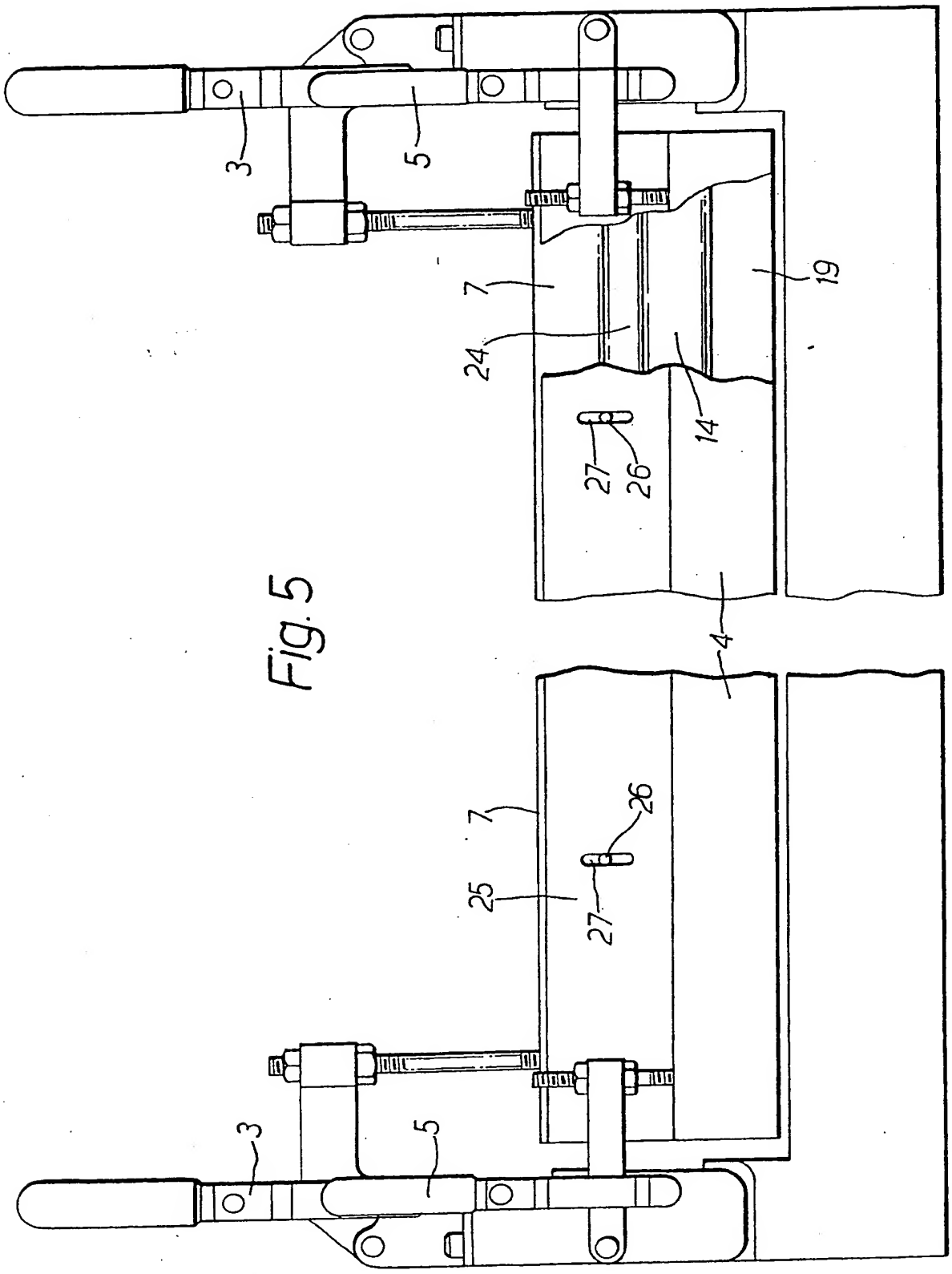
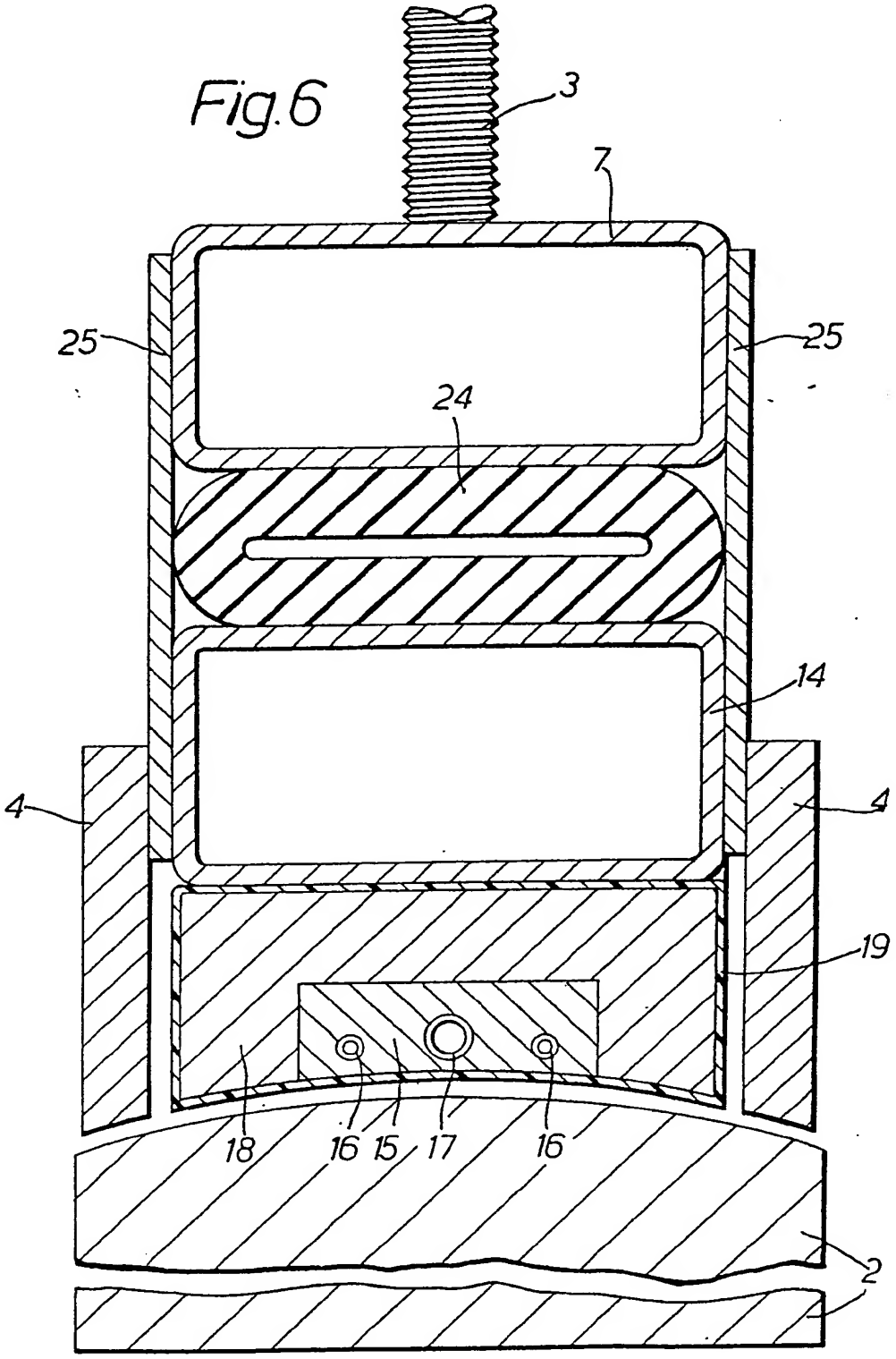


Fig. 5

Fig.6



SPECIFICATION

Apparatus for preparing cylindrical printing formes

Recently printing formes have been made by engraving a blank plastics printing forme with a laser, electron or ion beam. This technique has particular application to cylindrical printing formes for use in rotogravure printing.

We have found that the preferred construction of such a printing forme is to have the plastics material as a covering for a cylindrical metal or other support. The preferred polymer material is a polyacetal which is preferably a copolymer of formaldehyde and a cyclic ether containing an aklkylene chain of at least two carbon atoms and this is not suitable for coating a support by a dip or spray coating method. A typical cylindrical support has an external diameter of 330 mm and it is not possible to obtain the preferred polymer material commercially as an extruded tube of suitable diameter to be fitted over such a support. However, provided that such a tube can be prepared by welding from a sheet of material the resulting sleeve of plastics material may then be fitted onto the cylindrical support using a heating step to heat shrink the sleeve into intimate contact with the support or to expand the sleeve to enable it to be stretched over the support, so that, on cooling, it shrinks into intimate contact with the support. In both cases the sleeve tightly grips the support and is prevented from moving with respect to the support.

It is important that the joint between the edges of the sheet of polymer material is indistinguishable from the remainder of the sleeve so that the entire outer surface of the cylindrical printing forme may be used to receive an engraved image. The outer surface of the cylindrical printing forme is usually skimmed on a lathe to ensure that it has a perfectly true surface after the sleeve has been fitted to the cylindrical support and again after the completion of a particular print run of an image has been completed to enable the engraved image to be removed and the printing forme be re-used. Thus, it is essential that the joint between the two edges of the sheet is complete andhvoid free along its length and throughout its depth so that there are no measurable defects throughout the joint. This ensures that no print defects are present in the completed printing forme resulting from the welded joint, for example, from the presence of an air bubble included in the joint which has been exposed as an unwanted pit after the skimming operation on the forme. Further, any major imperfections in the joint may lead to damage to the doctor blade used with the cylindrical printing forme or damage to the printing forme as a result of severe contact between the doctor blade and any irregularities in the joint.

According to this invention an apparatus for jointing opposite edges of a sheet of plastics material to form a tubular sleeve comprises two opposed elongate platens at least one of which includes a strip heater extending along it with thermally insulating material extending along both sides of the heater, and clamp means to clamp the platens together to sandwich the plastics material to be joined between them with the joint extending along the platens adjacent the strip heater or heaters.

Preferably the apparatus also includes means to hold each side of the sheet in position on one of the platens before the other platen is clamped into engagement with it. These means enable the two sides of the sheet to be butted together accurately before the two platens are clamped together. Both platens may be curved in their transverse directions and if they are curved preferably their curvature is substantially equal to that of the printing forme for which the sleeve is being prepared. In this case the portion of the sleeve containing the welded joint has substantially the same curvature as that of the support and this ensures that the entire sleeve, including its welded joint, beds down readily onto the outer surface of the support when the sleeve is fitted to the support.

Preferably the, or each, strip heater includes at least two heating elements or at least two longitudinally extending independently controllable portions. In this case, the, or each, of the strip heaters preferably includes a central high power element, or portion of the heater, together with a lower power element, or lower power portion, which extends on both sides of the central element, or portion. With the heater or heaters arranged in this way the edges of the plastics sheet material are joined together and the two platens are brought together to clamp the plastics material between them. The outer heater elements are then operated to provide some softening of the adjacent edge regions of the sheet which, under the pressure exerted by the clamping means, ensures that the jointed edges are urged tightly together. The central, heating element is then operated to raise the temperature of the plastics material at the jointed surfaces so that the joint fuses to form a continuous weld. The central, heating element is then turned off and finally the outer elements are also turned off. Since the regions surrounding the weld are softened by the lower power heating elements any stresses built up in the welded joint is readily relieved by slight movements of the plastics material in these softened portions surrounding the welded region. The heat insulating material surrounding the, or each, heater ensures that at least part of the plastics material clamped between the two platens is not heated during the welding operation and so the thermally insulating regions hold opposite sides of the plastics sheet material which are not heated or softened in exact location throughout the jointing operation.

Preferably the opposed surfaces of the two platens are absolutely true and free from surface defects and irregularities. Preferably they are highly polished and they may include a release coating, for example, a coating of polytetrafluoroethylene or a layer of polyethyleneteraphlate. This layer improves the surface finish of the complete joint and protects the surface of the joint from contamination by the platens. Preferably the strip heater or heaters have a width between 1 cm and 2 cm and the platens are long enough to accommodate standard sizes of printing cylinder. The standard sizes of printing cylinders range up to 2.6 metres in length.

At least one of the platens may include pressure adjusting means distributed along its length, so that the nip pressure between the platens is variable. The apparatus may include a pressure bar engageable with the clamping means and have the pressure adjusting means acting between the pressure bar and the platen. The pressure adjusting means may be formed by a chamber at least partly bounded by the pressure bar and the platen to which fluid under pressure is admitted to force the pressure bar and the platen apart. Since the clamping means clamps the pressure bar to the other platen this results in the two platens being urged together by the fluid pressure. The platen and the pressure bar may fit together to define the chamber between them but preferably the chamber is formed by a piece of flexible hose sandwiched between the pressure bar and the platen, the arrangement being such that when fluid under pressure is supplied to the inside of the flexible hose it is inflated and applies a pressure to the pressure bar and the platen urging them apart.

In an alternative arrangement, the pressure adjusting means may be formed by a number of springs acting between the platen and the pressure bar. In this case, the load exerted by each spring is preferably variable to not only enable the nip pressure to be varied, but also, to enable the nip pressure to be set up so that it is substantially constant along the length of the platens.

The clamping means for the two platens and for the nip bars may be formed by simple over-centre toggle clamps or, alternatively, the clamping means may be formed by fluid pressure operated piston and cylinder assemblies acting between the two platens and against the nip bars, respectively.

The platens may also include cooling means arranged adjacent the heating element so that the weld can be cooled after it has been formed to reduce the period of time taken for the completed weld to set and so reduce the time for which the plastics material has to remain in the apparatus. In this case the cooling means preferably include a water cooling element to enable cooling water to be circulated through the platens.

It is also possible to include a longitudinally extending groove in the surface of whichever platen is arranged to be adjacent the outside of the sleeve. This longitudinally extending groove allows for some expansion of the plastics material into the longitudinally extending groove during the heating and welding operation. Any plastics material remaining in this groove at the completion of the joining operation forms a longitudinally extending ridge in the finished sleeve but, since the sleeve is trued up and finished by being skimmed on a lathe before use as a printing forme, this ridge is removed at that time and so does not marr the printing forme.

A particular example of an apparatus in accordance with this invention and two modifications of this apparatus will now be described with reference to the accompanying drawings; in which:-

Figure 1 is a partly cutaway front elevation of the apparatus;

Figure 2 is a sectional elevation of the platens of the apparatus shown in Figure 1;

Figure 3 is a front elevation of a first modification;

Figure 4 is a sectional elevation through the platens of the first modification;

Figure 5 is a front elevation of a second modification; and

Figure 6 is a sectional elevation of the second modification.

The apparatus comprises an upper platen assembly 1 and a lower platen 2 which are clamped together by a pair of over-centre toggle clamps 3. The apparatus also includes a pair of nip bars 4 which are each clamped onto the lower platen by a pair of over-centre toggle clamps 5. At least the top surface of the lower platen 2 is formed from a thermally insulating material, for example, Tufnol (Registered Trade Mark) and the upper surface is preferably coated with a release coating 6 of polytetrafluoroethylene. The upper platen assembly 1 and the lower platen 2 are slightly longer than the maximum length of rotogravure printing cylinders. The drawings show the central portion of the platens broken away for clarity. The width of the upper platen assembly 1 is between 1 and 2 cm and this width is shown exaggerated in Figures 2, 4 and 6 of the drawings. The facing surfaces of the upper platen assembly 1 and the lower platen 2 are curved in the transverse direction and this curvature is again shown exaggerated in Figures 2, 4 and 6 of the drawings. The curvature corresponds to that of a printing forme and a typical size is 330 mm in diameter.

The upper platen assembly 1 comprises a pressure bar 7 and an upper platen 8 which are connected at their ends by a pair of slotted links 9. A number of spring-loading devices 10 are arranged between the pressure bar 7 and the lower platen 8 along their lengths at a spacing which is typically 10 cm. Each spring-loading device 10 comprises a screw-threaded member 11 having a knurled head 12 bearing on a compression spring 13 which is arranged and acts between the screw-threaded member 11 and the top face of a backing bar 14 forming part of the upper platen 8. The pressure transferred from the pressure bar 7 to the lower platen 8 by each of the spring-loading devices 10 is variable by turning the knurled head 12 to screw the screw-threaded members 11 into or out of the pressure bar 7 to vary the length of the springs 13. In this way, the upper platen assembly 1 may be adjusted firstly to vary the pressure exerted in the nip between the upper and lower platens and secondly to adjust the nip pressure along the length of the platens to ensure that the pressure is substantially constant along their entire length.

The construction of the upper platen 8 is shown most clearly in Figure 2 and the upper platen 8 includes a metal heating block 15 having two elongate low power heating elements 16 and a single elongate high power heating element 17 embedded in it. Strips of thermally insulating material 18 extend along both sides of the heating block 15 and these strips of thermally insulating material may be formed from Tufnol (Registered Trade Mark). The heating block 15 and the thermally insulating strips 18 are enclosed in a sleeve 19 formed from

polytetrafluoroethylene. The heating block 15 and the insulating strips 18 are connected to the backing bar 14 by screw-threaded fasteners (not shown). A pair of stops 20 (see Figure 1) are provided at the ends of the upper platen 8.

In use one edge of a sheet of plastics material to be used for forming the covering of a printing forme is placed on the top surface of the lower platen 2 with the edge substantially aligned with the centre line of the lower platen 2. One of the nip bars 14 is then clamped on top of the sheet of plastics material by the over-centre toggle clamps 5. The opposite edge of the sheet of plastics material is then bent round in a circle and this opposite edge is placed on top of the lower platen 2. The two opposite edges of the sheet of plastics material are butt jointed and then the opposite edge of the sheet of plastics material is clamped into position by the other nip bar 4 and its over-centre toggle clamps 5. After a final check that the opposite sides of the sheet of plastics material are correctly butt jointed, the upper platen assembly 1 is placed in position above the butt joint in the plastics material and clamped into position using the over-centre toggle clamps 3. The toggle clamps 3 engage the pressure bar 7 and, act through the springs 13 to urge the upper platen 8 into tight engagement with the plastics material.

The low power heating elements 16 are then operated to heat the heating block 15. This leads to some softening of the plastics material beneath the platen 8 and, under the pressure exerted in the nip between the two platens, a pressure builds up in the softened plastics material. The stops 20 limit the downwards movement of the upper platen 8. After the low power heating elements 16 have had time to soften the plastics material the higher power heating element 17 is operated. This higher power heating element is aligned with the butt joint and heats the plastics material until it fuses and welds together. Expansion of the plastics material caused by the heating operation leads to a high pressure between the nip of the two platens and ensures that a good contact is achieved between the opposite edges of the sheet of plastics material so that the welded joint so formed is substantially void free. The high power heating element 17 is then turned off so allowing the plastics material to cool into a plastic state and, thereafter, the lower power heating elements 16 are turned off. The heating block 15 is then allowed to cool to allow the plastics material between the nip of the platens to solidify.

The thermally insulating strips 18, together with the thermally insulating surface of the lower platen 2 ensure that the portion of the plastics sheet in the nip between these is not heated and consequently ensure that the portion of the plastics sheet material in the nip between these remains in a substantially fixed position during the welding operation. The release coating 6 on the top surface of the lower platen 2 and the sleeve 19 around the upper platen 8 ensure that the plastics material does not adhere to either of the platens. The opposed surfaces of both platens are highly polished so that the surface of the welded joint is as smooth as possible. After cooling, the toggle clamps 3 and 5 are released to allow the nip bars 4 and the upper platen assembly 1 to be removed and thereby allow the completed sleeve of plastics material to be removed from the apparatus. The sleeve is then fitted over a cylindrical support by a heat-shrinking operation.

In the first modification of the apparatus shown in Figures 3 and 4 the lower platen is replaced by a thin curved strip 21 which is preferably formed by a strip of polytetrafluoroethylene and the framework of the apparatus is arranged to hold journals 22 of a cylindrical support 23 of a printing member. The remainder of the apparatus is substantially identical to that described with reference to Figures 1 and 2.

In use the sheet of plastics material is first wrapped around the cylindrical support 23 and then one edge is clamped in place with its edge along the centre line of the curved strip 21 by one of the nip bars 4 and its clamps 5. The other edge of sheet of plastics material is then butt joined and again clamped in place by the nip bars 4 and the clamps 5. The upper platen assembly 7 is then lowered over the butt joint and clamped in position by the over-centre toggle clamps 3. This sandwiches the plastics material and the thin strip 21 between the upper platen 8 and the surface of the cylindrical support 23. The operation of the apparatus is carried out in exactly the same way but, upon completion of the welding operation, the support cylinder 23 is removed and then the curved strip 21 slipped out from beneath the sleeve of plastics material. The plastics sleeve is then heat-shrunk onto the cylindrical support 23.

In the second modification of the apparatus shown in Figures 5 and 6, the individual spring-loading devices 10 are replaced by a continuous spring formed by a flexible hose 24. The backing bar 14 in this modification is formed by a square section hollow tube and the pressure bar 7 is also formed by a square section hollow tube. A pair of side plates 25 connect the pressure bar 7 and the backing bar 14. The side plates 25 are fixed to the backing bar 14 and coupled to the pressure bar 7 by pins 26 mounted in the pressure bar 7 and slots 27 in the side plates 25. The pin and slot connections allow the pressure bar 7 and the backing bar 14 to be urged apart by the flexible hose 24. Thermally insulating material 18 has a channel-shaped cross-section in this modification. Fluid under pressure is introduced into the hose 24 so that it urges the pressure bar 7 and the backing bar 14 apart and increases the pressure applied in the nip between the platens. When this modification is used, a very uniform pressure is obtained along the length of the platens as a result of the fluid pressure applied to the hose 24.

CLAIMS

1. An apparatus for jointing opposite edges of a sheet of plastics material to form a tubular sleeve comprising two opposed elongate platens at least one of which includes a strip heater extending along it with thermally insulating material extending along both sides of the heater or heaters, and clamp means to clamp the platens together to sandwich the plastics material to be joined between them with the

joint extending along the platens adjacent the strip heater or heaters.

2. An apparatus according to claim 1, also including means to hold each side of the sheet in position on one of the platens before the other platen is clamped into engagement with it, so enabling the two opposite sides of the sheet to be positioned accurately before the two platens are clamped together.

3. An apparatus according to claim 1 or 2, in which the, or each, strip heater includes at least two heating elements or at least two longitudinally extending independently controllable portions.

4. An apparatus according to claim 3, in which the, or each, of the strip heaters includes a central, high power, heating element, or portion of the heater, together with a lower power heating element, or lower power portion, extending on both sides of the central, heating element, or portion.

5. An apparatus according to any one of the preceding claims, in which the clamp means engages a pressure bar and at least one of the platens includes pressure adjusting means distributed along its length, so that the nip pressure between the platens is variable, the pressure adjusting means acting between the pressure bar and the at least one platen.

6. An apparatus according to claim 5, in which the pressure adjusting means includes a chamber at least partly bounded by the pressure bar and the at least one platen, the chamber being arranged to receive fluid under pressure to urge the pressure bar and the platen apart and thereby increase the pressure subsisting in the nip between the platens.

7. An apparatus according to claim 5, in which the pressure adjusting means includes a number of springs, the loading on which is variable.

8. An apparatus according to any one of the preceding claims, in which the opposed surfaces of the two platens are covered with a release layer of or formed by polytetrafluoroethylene or polyethyleneteraphlate.

9. An apparatus according to any one of the preceding claims, in which both platens are curved in their transverse direction, their curvature corresponding to that of the tubular sleeve being prepared.

10. An apparatus according to claim 1, constructed substantially as described with reference to the accompanying drawings.

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